

Probability, Statistics, and Data Analysis

Course Description

The Probability and Statistics Course Standards from the South Carolina Mathematics Curriculum Standards are shown in green and in bold print at the places in the course outline where they should be addressed. In many cases, a standard will be found in more than one place in the outline.

Probability, Statistics, and Data Analysis is a course in which students learn the fundamental principles of probability and statistics and apply these principles to data analysis. Students are expected to utilize scientific calculators, graphing calculators, and/or computer software throughout the year.

Teachers should encourage their students to utilize the skills emphasized in this course through projects, investigations, case studies, and other appropriate methods.

Students will

- work with a set of data to perform statistical analyses and summarize the results;
- examine ways to organize and display data to draw conclusions about relationships that may exist in the data set;
- describe and summarize data numerically using central tendency, variation, and position statistics;
- describe and summarize data numerically using distributions;
- utilize statistical applications to solve a wide variety of problems from agriculture, biology, business, economics, education, psychology, engineering, medicine, sociology, and computer sciences;
- use counting methods and probability formulas to evaluate the likelihood of events occurring; and
- apply probability and statistical tests as decision-making tools in hypothesis-testing applications.

Recommended Prerequisites

Students entering this course should have successfully completed Algebra 1 and Algebra 2, having mastered all state-mandated standards in Algebra 1 and Algebra 2.

Course Outline

- I. Foundations of data analysis.
 - A. Differentiate between descriptive and inferential statistics. **Probability and Statistics: I A.2.**
 - B. Identify and classify variables. **Probability and Statistics: I.B.1.**
 1. Discrete or continuous.
 2. Categorical or quantitative.
 - C. Identify and classify methods of data collection.

1. Identify basic sampling techniques. **Probability and Statistics: I.A.2, 3., III.A.1.,2.**
 - a. Random.
 - b. Systematic.
 - c. Stratified.
 - d. Cluster.
 2. Discuss the advantages and disadvantages of various sampling techniques.
 3. Distinguish among surveys, observational studies, and controlled experiments. **Probability and Statistics: I.A.1.,4.,5.,6.**
 4. Recognize the method of data collection used to gather data from a given statistical study and evaluate the legitimacy of conclusions about the population based on the sample(s) studied. **Probability and Statistics: I.A.2.**
 5. Identify and discuss bias factors (e.g., voluntary response, convenience). **Probability and Statistics: I.B.2.**
 - D. Distinguish between statistic and parameter. **Probability and Statistics: I.D.1.**
- II. Univariate data displays.
- A. Determine an appropriate data display, and construct the display. **Probability and Statistics: I.C.1.,2., II.A.1.,2., II.B.4.**
 1. Pictograph. **Probability and Statistics: II.A.1.**
 2. Dot plot. **Probability and Statistics: II.A.1., 2.**
 3. Bar graph. **Probability and Statistics: I C.1., II.B.4.**
 4. Pie chart. **Probability and Statistics: I.C.1.**
 5. Frequency distributions.
 - a. Categorical frequency distribution (Pareto chart). **Probability and Statistics: I.C.1., II.B.4.**
 - b. Histogram. **Probability and Statistics: I.C.2..**
 - c. Frequency polygon.
 - d. Cumulative frequency distribution (ogive).
 6. Time series plot.
 7. Stem plot (stem-and-leaf). **Probability and Statistics: I.C.1.,2..**
 - a. Standard.
 - b. Back-to-back (to compare two data sets with common stems).
 - c. Expanded (stem expansion based on the number of data values within the stem; i.e., group by five or two as needed).
 - d. Truncated (data is rounded before use)—optional.
 8. Box plot (box-and-whisker)—teach in conjunction with measures of position. **Probability and Statistics: I.C.1.,2.**
 - a. Single.
 - b. Parallel (horizontal or vertical arrangement with a common scale for comparing data sets).
 - B. Interpret the graphical display.
 1. Center. **Probability and Statistics: I.D.2., II.C.1.**
 - a. Mean.
 - b. Median.

- c. Mode.
 - d. Midrange.
 - 2. Spread. **Probability and Statistics: I.D.2., II.C.1.**
 - a. Range.
 - b. Variance.
 - c. Standard deviation.
 - d. Mean deviation (optional).
 - e. Interquartile range (IQR).
 - 3. Position. **Probability and Statistics: I.D.3.**
 - a. Median.
 - b. Quartiles.
 - c. Deciles.
 - d. Percentiles.
 - e. Standard scores (z-scores).
 - 4. Shape. **Probability and Statistics: II.A.1., II.C.2.**
 - a. Symmetric.
 - b. Skewed.
 - 5. Outliers. **Probability and Statistics: I.C.1.,2.**
- III. Bivariate data and scatter plots.
- A. Construct a scatter plot from given data. **Probability and Statistics: II.B.3.**
 - B. Describe the shape of a scatter plot as linear, quadratic, or exponential.
Probability and Statistics: II.B.3.
 - C. Examine scatter plots to determine positive, negative, or no correlation.
Probability and Statistics: I.D.5.
 - D. Find and interpret the value of the coefficient of determination, r^2 .
Probability and Statistics: II.B.1.,3..
 - E. Find and interpret the value of the correlation coefficient, r . **Probability and Statistics: II.B.1., 3.**
 - F. Write a linear equation that represents the relationship between the variables.
Probability and Statistics: II.B.2.,3.
 - 1. Intuitive methods (estimate using linguini or clear ruler). **Probability and Statistics: II.D.1.**
 - 2. Linear regression using a graphing calculator or computer software.
Probability and Statistics: II.D.2.
 - G. Make predictions (interpolate or extrapolate). **Probability and Statistics: II.B.2.**
 - H. Explain limitations of the linear model. **Probability and Statistics: II.B.2.,3.**
- IV. Basic probability concepts and applications.
- A. Apply counting techniques to determine the number of outcomes.
Probability and Statistics: IV.A.1.
 - 1. Tree diagram. **Probability and Statistics: IV.A.2.**
 - 2. Counting principle. **Probability and Statistics: IV.D.3.**
 - 3. Permutations (with and without repetition). **Probability and Statistics: IV.A.1.**
 - 4. Combinations. **Probability and Statistics: IV.A.1.**

- a. Pascal's triangle and binomial coefficients. **Probability and Statistics: IV.A.3.**
 - b. Committees as subgroups of larger group. **Probability and Statistics: IV.A.1.,2.**
- B. Determine and display a sample space. **Probability and Statistics: IV.A.2.**
 - 1. List.
 - 2. Chart.
 - 3. Picture.
 - 4. Tree diagram.
- C. Compute and display classical (theoretical) and empirical (experimental) probability. **Probability and Statistics: IV.E.1.**
 - 1. Simple.
 - 2. Complementary.
 - 3. Compound. **Probability and Statistics: IV.E.1.**
 - a. Mutually exclusive (disjoint) events. **Probability and Statistics: IV.D.1.**
 - b. Inclusive (joint) events.
 - c. Independent events.
 - d. Dependent events.
 - 4. Conditional probability. **Probability and Statistics: IV.D.2.**
 - 5. Venn diagrams and/or two-way tables to illustrate simple, complementary, compound, and conditional probability. **Probability and Statistics: IV.A.2.**
- D. Conduct and interpret simple probability experiments. **Probability and Statistics: IV.B.1.,2.**
 - 1. Manipulatives (e.g., spinners, dice, cards, coins).
 - 2. Simulations (using random number tables, graphing calculators, or computer software).
- V. Probability distributions.
 - A. Construct a classical (theoretical) probability distribution using a sample space. **Probability and Statistics: IV.A.1.**
 - B. Construct an empirical (experimental) probability distribution using simulation. **Probability and Statistics: IV.B.1.**
 - C. Compare classical (theoretical) probabilities from the sample space to the empirical (experimental) probabilities from a simulation. **Probability and Statistics: IV.B.1.**
 - D. Calculate the mean, variance, and expected value of a discrete random variable. **Probability and Statistics: IV.C.1.,2.**
 - E. Contingency or two-way tables
 - 1. Display variables in a two-way table. **Probability and Statistics: I.C.3.**
 - 2. Calculate marginal distributions in a two-way table. **Probability and Statistics: I.D.4.**
 - F. Find the exact probability of a specific number of trials from a binomial experiment. **Probability and Statistics: IV.A.3.**

- G. Find the mean, variance, and standard deviation for the variables of a binomial distribution. **Probability and Statistics: IV.A.3.**
 - H. Find the probabilities for outcomes of variables using other distributions such as geometric and Poisson (optional).
- VI. Statistical inference.
- A. Identify the properties of a normal distribution and apply the empirical rule to data displaying a normal distribution. **Probability and Statistics: II.A.3.**
 - B. Find the area under the standard normal curve given various z values and vice versa. **Probability and Statistics: I.D.3.**
 - C. Find the probability for a normally-distributed variable by transforming it into a standard normal variable and vice versa. **Probability and Statistics: I.D.3.**
 - D. Use the central limit theorem to solve problems involving sample means for large and small samples. **Probability and Statistics: III.B.1.,2.**
 - E. Use the normal approximation to compute probabilities for a binomial variable. **Probability and Statistics: IV.A.3., B.1.,2.**
 - F. Find the confidence interval for the mean with a known or unknown standard deviation for small and large sample sizes. **Probability and Statistics: III.D.1.**
 - G. Find the confidence interval for a population proportion. **Probability and Statistics: III.D.1.**
- VII. Hypothesis testing.
- A. Write null and alternative hypotheses.
 - B. Find critical values for testing a mean or proportion against the population mean or proportion using the appropriate test, based on the sample size. **Probability and Statistics: III.D.2.**
 - C. Find critical values for testing the difference between two means or two proportions using the appropriate test, based on the sample size. **Probability and Statistics: III.D.2.**
 - D. Test hypotheses using confidence intervals. **Probability and Statistics: III.D.1.**
 - E. Test observed values versus expected values using the chi-square test. **Probability and Statistics: IV.C.1.,2.**
- VIII. Project design.
- A. Validity of Statistical Studies **Probability and Statistics: III.C.1.,2.**
 - 1. Given a published report based on data, determine:
 - a. Design of the study
 - b. Appropriateness of the data analysis
 - c. Validity of the conclusions
 - d. Interpretation of results
 - B. Use any of the statistical and probability knowledge to design a culminating project.
 - 1. Experiments. **Probability and Statistics: I.A.1.-7., B.2.**
 - 2. Observational studies. **Probability and Statistics: I.A.1.**
 - 3. Surveys.
 - C. Collect, analyze, and display the data. **Probability and Statistics: I.A.2.3., C.2., III.A.1.,2.**
 - D. Produce a report.